Roofing Shingles Practices and Innovation

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Summary

The more common roofing shingle materials are timber, slate and asphalt. All classes of timber and slate are not equally suitable for making shingles. Asphaltic shingles are suitable for temperate countries only. The shortage of shingle grade timber and slate has made man look for new alternatives to these raw materials. The paper gives, in brief, various practices adopted in the use of conventional shingle materials including a number of improvements in their use suggested from time to time as well as as development of alternative shingle materials using non-conventional materials including metals and plastics. It also describes the various efforts being made to produce low cost roofing shingles with special reference to this country.

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Introduction

Hilly areas and other places having heavy rain-fall have pitched roof buildings with a steep slope. The roof covering over such a roof is supposed to provide a durable waterproof cover to protect the building from rain, snow, wind and to some extent from heat and cold. The material used for covering such roofs is called shingle. The shingle is a thin small slab made of timber, slate, asphalt, asbestos, stone, plastics or any other composite material. The shingles are normally laid over the top of closely fitted wooden planks called underlay which is provided to take the load of the roof which is covered with snow during winters especially on higher altitudes.

Shingles should possess the following prerequisites to make them really useful :

1. sufficient strength to withstand varying conditions of moisture, snow and rapid changes in temperature and other weathering agents.
2. high degree of dimensional stability i.e. low ratio of tangential to radial shrinkage and minimum shrinkage and swelling in all planes.

3. good nail holding property i.e. freedom from splitting during nailing.
4. Light in weight for ease of transportation and also reducing roof load to enable the use of purlins of lighter sections in the sub-structure.
5. good abrasion-and decay resistance.
6. not susceptible to cracking, warping or deformation on ageing and
7. good in appearance and ability to take decorative finish.

Timber Shingles

Shingles made out of timber have been used from the earliest historical times probably due to their ease of local availability and durability. In the begining, these were prepared manually and used both for roofing as well as for wall siding. These shingles were generally of two types viz. lap and joint. The former were longer with one edge thicker than the other and nailed on the underlay so that edges were overlapped on one another. The latter were, however, nailed side by side. With the advent of mechanization, timber shingle production became less expensive and less time consuming. By 1845, though mechanised shingle production was started in Pacific Northwest, large scale mechanised production got a break-through on introduction of Block single Machine in Canada.

Timber shingles are reported to have a very long life provided these are made from proper grade of timber by a suitable method. Some of the timbers suitable for making shingles are western red cedar, northern and southern white cedars, red wood and cypress. In India deodar, cypress and thingan are good shingle timbers and these are distributed in the sub-Himalayan tract and outer Himalayas. Fir, chir, kail and semul can also be used for making roofing shingles after giving them preservative treatment. These are also distributed in the sub-Himalayan tract. Among the regional shingle timbers, mundani is used in Mysore, Indian chestnut in Darjeeling and pali on the west coast.

In the same type of timber, composition of the timber and its grains in the shingle play a vital role in its life. Sapwood of all species is poor in decay resistance and hence better shingles can be prepared entirely from heartwood. Edge grain shingles are superior to flat grain shingles as the former have considerably less tendency to warp in service. All hertwood, edge grain, clear stock timber is, therefore, the most ideal material for making long lasting shingles.

Depending upon the type of timber, heratwood and sapwood content and quality of grains, the timber shingles are classified into three types. Type I shingles are all edge-grain, strictly clear and contain no sapwood. Type 2 and 3 shingles must be clear atleast to a good distance from the butt. While type 2 allows a limited amount of sapwood, type 3 allows any amount of it. Diagonal grains and cross grains are avoided in type 1 and badly crossed grains are not permitted in any case. Proportion of shingles less than 10 cm in width is limited to 10, 20 and 30 per cent respectively in the three types.

Timber shingles are usually prepared by sawing timber logs in standard lengths of 40 cm with varying widths of 8 to 20 cm. Higher width in shingles is not preffered due to their susceptibility to curb and warp. Shingles are usually made tapering with 7.5 to 10 mm thickness at the thick or butt edge and 1.5 to 3 mm at the thin edge. These are cut from quartered log and are rift sawn more or less at right angle to the rings. Flat grain shingles, on the other hand, are sawn from short, round or split bolts parallel to annual growth rings. Edge grain shingles split less easily on nailing and are less likely to lose their shape from being out during weathering. These also shrink less in width.

Shingles prepared from exceptionally good quality of timber, e.g. with heartwood of red cedar, are very durable and do not require any preservative treatment. Decorative finishes can, however, be given over them. Shingles prepared from not so good timbers and those containing some sapwood, however, require appropriate staining and preservative treatment. This treatment can be given by either dipping orbby pressure impregnation. There are many advantages of staining and preservative treatment. Apart from giving attractive colour of one's choice it appreciably reduces swelling and shrinkage during wetting and drying periods. It protects the sapwood from insects and fungal attack and also reduces mechanical abrasion of the shingle surface due to attrition by sand and dust particles, thus prolonging the life of the shingles. It also checks the mild hydrolysis of the surface layer of timber and leaching due to exposure to rains.

Efforts were also made from time to time to make the timber shingles fire resistant. This was done by treating them with phosphonium chloride-urea polymer, melamine-dicyandiamide-formaldehyde-phosphoric acid system and a number of other formulations by vacuum or pressure impregnation. These were found to be quite effective, stable and also leach-resistant.

Asphalt Shingles

Asphalt shingles are small pieces of asphalt felt surfaced with coloured mineral granules and are intended to be laid in overlapping courses in much the same way as timber or slate shingles. These shingles are more suited to countries with temperate climate. These are prepared by a method similar to that of tarfelt. It is composed of three basic materials, asphalt, felt and mineral granules. The manufacture of asphalt shingles is a multistage fully mechanised process. Chief operations in its manufacture are preparing of felt, saturating of felt, stabilizing by surface coating of asphalt, application of mineral granules, embossing of pattern, cooling, cutting and packaging. Cellulosic and other materials are used for making the felt and asphalt is used as a saturant. For surface coating a harder grade of asphalt is used. Asphalt coating and application of mineral

granules protect the shingles against weathering. Asphalt shingles can also be prepared with thicker butt end which may be achieved by various methods.

These shingles can be prepared in a number of colours. These can be imported a uniform colour by applying a single coloured granule on the entire surface. Different colour patterns can be given by applying granules of different colours in different designs. These granules should, however, be applied to only that area of the shingle which is supposed to be exposed to weather. Individual asphalt shingles can be classified in a number of types depending upon their geometrical patterns, freeness of butts, spacing of shingles and folded or unfolded metal fasteners.

Shingles surfaced with mineral granules are, sometimes, further covered with pigment, hydraulic cement, slate, veneer, tile, asbestos cement etc. Their surface can also be protected by cementing aluminium foil or spraying the surface with molten metal, glass or even pigmented synthetic resin compositions. Edges of the shingle can be protected with sheet metal. Specially strong asphalt shingles were prepared by reinforcing them with a sheet metal core or wire mesh or even laminating with several layers of asphaltic fabricks, asbestos felt or timber veneers.

Fire resistant asphalt shingles with reduced tendency to flow at elevated temperatures, were prepared by bonding the asphalt felt to a glass fibre textile and coating with fibre reinforced asphalt to which mineral granules are bonded. The properties of asphalt shingles were also improved by covering them with a layer of crushed white porcelain and pressing. After blowing off excess granules the surface was sprayed with dry white portland cement while the coating was still hot. The surface was moistened with a fine mist of a solution of sodium silicate and set by heating.

Slate shingles

Slate shingles are very common at places where good quality slates can be procured from nearby sources. Its popularity is due to its ease of preparation, fixation, good weather resistance and durability apart from low cost. Slate is obtained in the form of fine-grained argillaceous rock derived from mud stones, silt-stones and other clayey sediments. The most important characteristics of slates is their perfect fissility or cleavage. It is supposed to be formed from clay and shale as a result of compression and deformation carried out by earth pressures. High pressure rearranges the tiny clay minerals into thin layers which can be later split into sheets. Workmen split the slate into thin layers with chisel and then these are trimmed to required size either by hand or with the help of motor driven rotating knives. Thickness varies with the quality of the slate rocks. Average thickness of a good quality slate shingle is 5 mm.

Usual colours of slate are black, dark grey, greenish grey and purplish grey. Slates of different colours may sometimes be used to give the roof an attractive appearance. In some cases colour may fade away in weathering. Slates are of varying degree of hardness depending upon the source. Slates containing deleterious minerals (pyrite or free coarse calcite) are not durable and should not be used. Micaceous and chloritic slates, free of carbonates, usually have good weather resistance.

Good quality slate reserves are not well distrbuted in the country and its reserves in the northern Himalayan belt are quite inadequate to meet their requirement as shingles in the hilly areas of northern India. Biggest reserves of good slate rock in this country are in the states of Haryana and Himachal Pradesh. Kashmir has some reserves of slate rocks but these are of poor quality and are not fit for making shingles.

Slate shingles are very durable and fire-proof yet these have two limitations. Firstly due to their brittle nature, there is difficulty in their long distance transportation particularly in the hilly areas and secondly due to their heavy weight these require thicker wooden sections in the sub-structure of the roof. Even otherwise only good quality slate should be used since in the case of poor quality slate deterioration takes place under and betweem the slates. The effects are only visible when the shingles begin to break at the nail holes and slide out of position. Sometimes blistering and scaling occur even on the outer surfaces.

Innovations

Shortage of conventional shingle materials such as timber and slate at various places has pressed man to look for other alternatives based both on natural and synthetic resources. Non-rusting and durable metallic shingles such as those prepared from aluminium had an expected life of 60 years. These shingles could, however, not catch up due to their prohibitive cost. Very attractive shingles of various colours and patterns are reported to have been prepared from a number of plastics. The plastic shingles, though have a long life of about 40 years, yet their use could not be promoted due to their high cost.

Thermally polymerizable compounds containing styrene and maleic anhydride were used as impregnant for timber shingles to improve their dimensional stability, water repellency and mechanical properties. Acrylic-polyethylene latex coating on asbestos cement shingles has been found to prevent their scuffing. In another approach sandwiched thermal barrier laminates with polyisocyanurate foam with aluminium facing on both sides were prepared. Fire resistance of these laminates was improved by introducing a thrid aluminium sheet in the centre of the sandwich. By another formulation very tough fire and weather-resistant roofing shingles were prepared from glass fibre and aluminium oxide trihydrate reinforced ethyelene dimethacfylate-methyl methacrylate copolymer. These shingles were found to possess high impact strength and long life. In another innovation blast furnace slag wool was found to replace asbestos partially in asbestos shingles without adversely effecting its properties.

Low Cost Substitutes

In addition to the various innovations described above, efforts were also made to find out a low cost substitute for timber and slate shingles. The substitute was meant to preserve the dwindling forest reserves of shingle grade timber which are not planted at the rate at which these are consumed. It was also supposed to meet the shortage of good quality slate as their reserves are fast depleting. Most of these attempts have utilised timber based or forest based waste fibres in various forms for producing roofing shingles. A few of them make use of wood pulp for making a matt and then making them weather resistant by impregnating with asphalt or other such substances. Both mechanical and chemical wood pulp were blended in suitable proportions to give a good base material for roofing shingles. Other similar formulations utilize fibres from rags, jute and small amount of fibres of wood, rayon, silk etc. More recently experiments have shown that good quality shingles can be prepared from mechanically fibrized wood residue using waste wood left after taking out sleepers from log.

As far as India is concerned, shingle grade timber is not well distributed in the entire Himalayan belt. Moreover, the reserves of slate, which is the chief alternative shingle material in this country, are fast depleting. This is causing a growing concern that unless a suitable substitute is developed, there are chances of using sub-grade timbers for making shingles which have a very poor performance as discussed earlier.

Efforts are being made jointly by Central Building Research Institute, Roorkee and Regional Research Laboratory, Jammu to develop a durable as well as low cost roofing shingle from pine needles, cellulosic wastes, asphalt and other materials. Pine needles have been selected as a suitable raw material because these are obtained in huge quantities in the form of renewable forest waste from chir pine. This tree grows widely all over the sub-Himalayan belt at an altitude of 500-1500 metres. The fallen leaves, which are incidentally also a big fire hazard to the forest, can be got collected through organised contractors and converted into base boards by chemical and mechanical processes with the help of other cellulosic fibres. These boards will be rendered water and weather resistant by chemical treatments so that these could be used as a possible low cost substitute for timber and slate shingles.

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